Usability Testing and Analysis Facility (UTAF)

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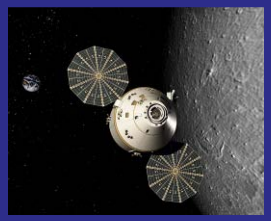


UTAF Overview

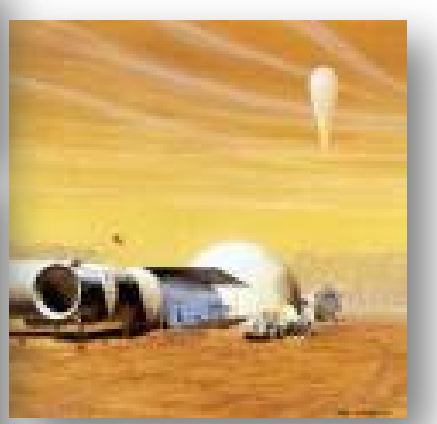
- **One of the Space Human Factors Laboratories in the Habitability and Human Factors Branch (SF3) at NASA Johnson Space Center**

- **Primary focus: Human factors evaluation and usability testing of crew / vehicle interfaces**

- **Staff**
  - **NASA Technical Monitor: Doug Wong**
  - **Contractor Lead: Kritina Holden**
  - **Current number of staff members: 10**

UTAF Expertise and Capabilities

- **Unique mix of backgrounds**
  - Human factors and usability
  - Engineering psychology
  - Human-computer interaction
  - Industrial engineering
  - Biomedical engineering
  - Visual and auditory perception
  - Attention and memory
  - Learning and decision making
  - Aviation psychology


UTAF
Processes / Methodologies

Human Factors

- Human-Centered Design
- Human-system integration requirements development and interpretation
- Observational/Ethnographic studies
- Task analysis and function allocation
- Scenario and script development
- Information architecture and interaction design
- Human factors assessment
- Heuristic evaluation
- Cognitive walkthrough
- User testing/Human-in-the-loop testing
- User interface design and testing (e.g., websites, software displays, hardware panels and controls, and procedures)
- Applied human factors research
- Human performance modeling
- Error analysis
- Link analysis
- Workload and situational awareness

General

- Questionnaire and survey design
- Research methods and experimental design
- Parametric, non-parametric, and multivariate statistical analysis
- Proposal development
- Technical writing

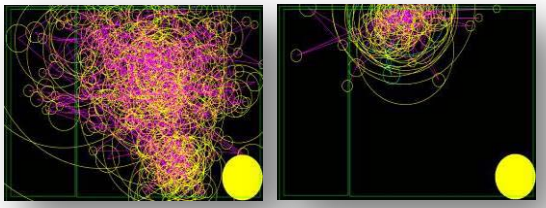
UTAF Equipment

- **UTAF consists of:**
  - **Isolated subject and control rooms**
  - **Video recording, editing, and analysis equipment**
  - **Eye- and head-trackers**
  - **Hardware and software tools**
    - **Flight-like computers**
    - **User interface prototyping tools**
    - **Specialized statistical analysis software**
    - **Survey software**
    - **User testing and recording tools with remote site testing capability**
    - **Multi-media, web-based, and statistical tools**

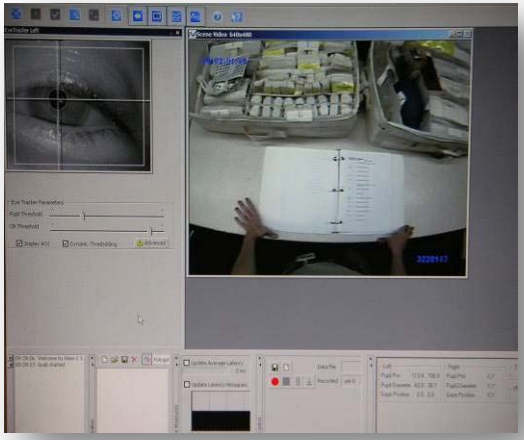
- **Access to analog environments:**
  - **Reduced gravity aircraft (C9, zero-g plane)**
  - **ISS, Shuttle, Orion mock-ups**
  - **Neutral Buoyancy Laboratory**
  - **Testbed Facilities (chamber, NEEMO)**

Key Functions and Products

- **Key Functions**
  - Human factors consultant/team member
  - Advocate for crew
  - Facilitate Human-Centered Design
  - Evaluate user interface designs through heuristic and established usability evaluation methods
  - Space human factors research

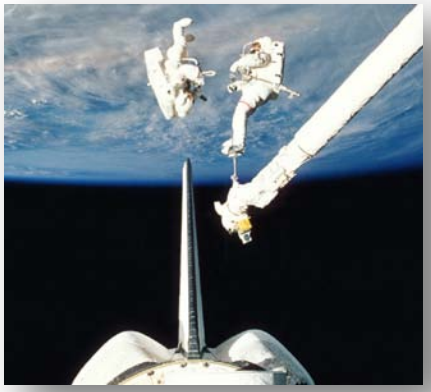


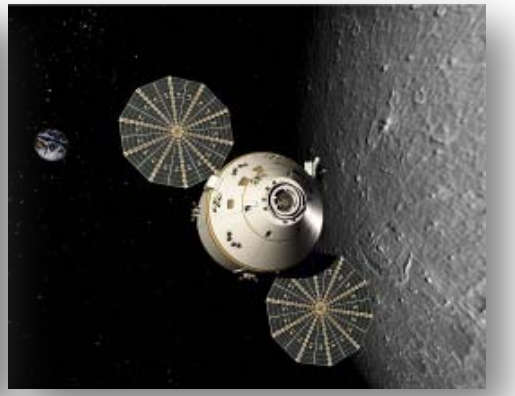
- **Products**
  - Human engineering requirements
  - User interface development
  - Displays and controls
  - Workstation systems
  - Work environments
  - Task procedures



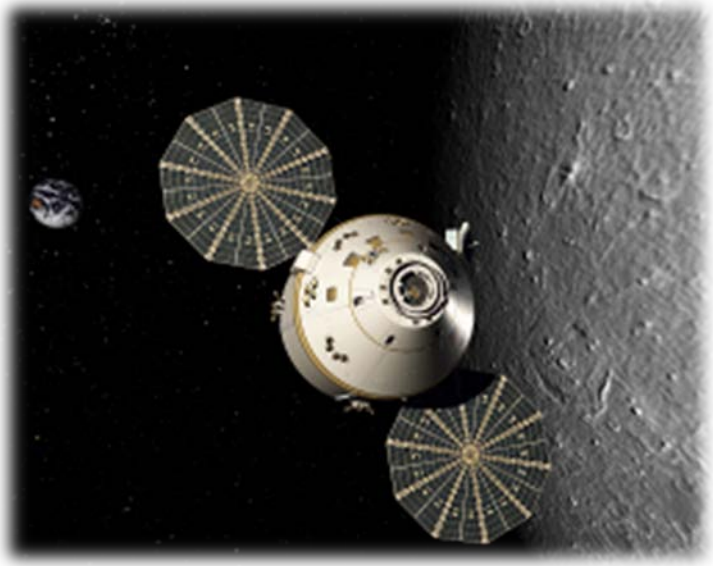
UTAF Program and Research Support

- **Human factors support to major space programs**
  - **Constellation Program (CxP)**
    - **Orion Crew Exploration Vehicle, EVA, Altair, and Lunar Habitats**
  - **International Space Station**
  - **Commercial Orbital Transportation Services (COTS)**
- **Space human factors research**
  - **Space Human Factors Engineering Directed Research funded by the Human Research Program**
    - **Information Presentation ,Training, Usability, Human-Robot Interaction**
  - **Research projects with external businesses and universities**



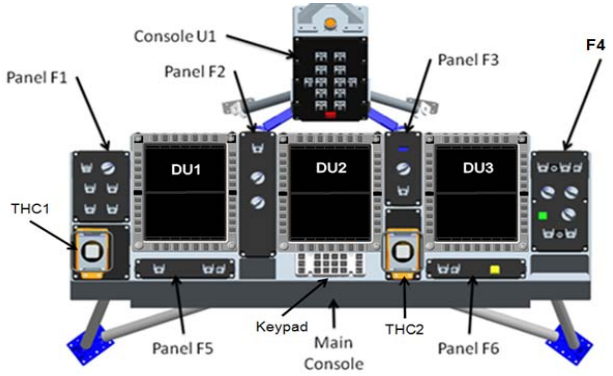


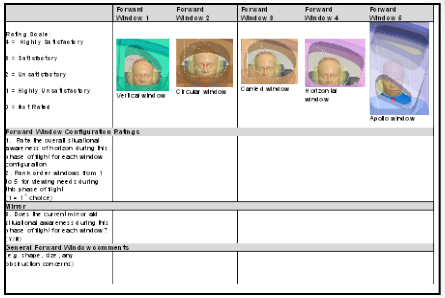
CxP Orion Support



Orion Human Engineering Activities

- **Human-systems requirements development**
- **Mission-level task analyses**
- **Practice-oriented evaluations using low-fidelity CEV mock-ups:**
  - **Crew module internal layout: seats, display & control panels and other systems / sub-systems**
  - **Window size and location**
  - **Net Habitable Volume (NHV)**
  - **Displays and Controls Console Design**
  - **Software Display Formats**

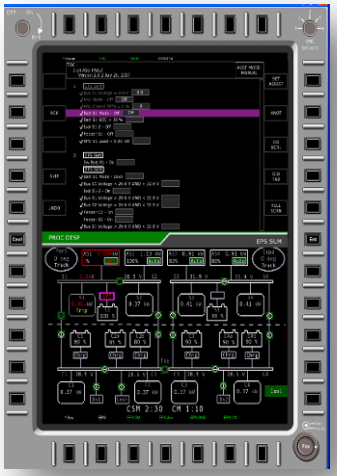




Orion Displays and Controls

Displays

- Conduct hierarchical task analysis
- Support ConOps development
- Support display format standards development
- Develop display evaluation process
- Conduct crew evaluations of display prototypes
- Evaluate electronic procedures
- Owner of workload and usability requirements



Controls

- Conduct crew evaluations of cursor control device concepts



- Test unpressurized and pressurized glovebox usability with representative task scenarios / displays

- Hand controller evaluations

- Edge key and panel ops evaluations
- Effects of vibration on use of controls

CxP EVA Support

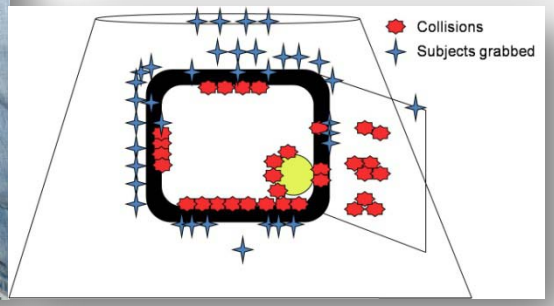
EVA Integrated Suit Test

Exploration Task Analyses

Simulated geology tasks – shoveling rocks


EVA hammering task


1-g Emergency Hatch Egress



CxP Lunar Projects: Altair, Lunar Electric Rover, and Outposts

Altair Lunar Lander

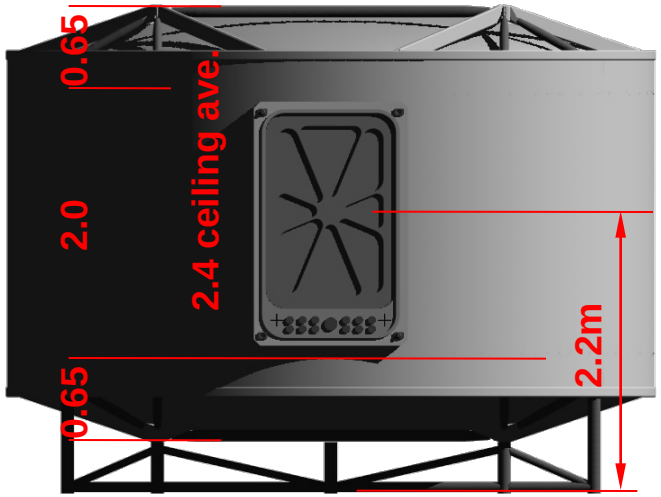
- **Evaluate habitable volume, mission operations, overall design**
  - **Suited and unsuited groups performing functional tasks (eating and sleeping, medical events, maintenance, etc.)**
  - **This aids in studying the crew's net habitable volume (NHV)**

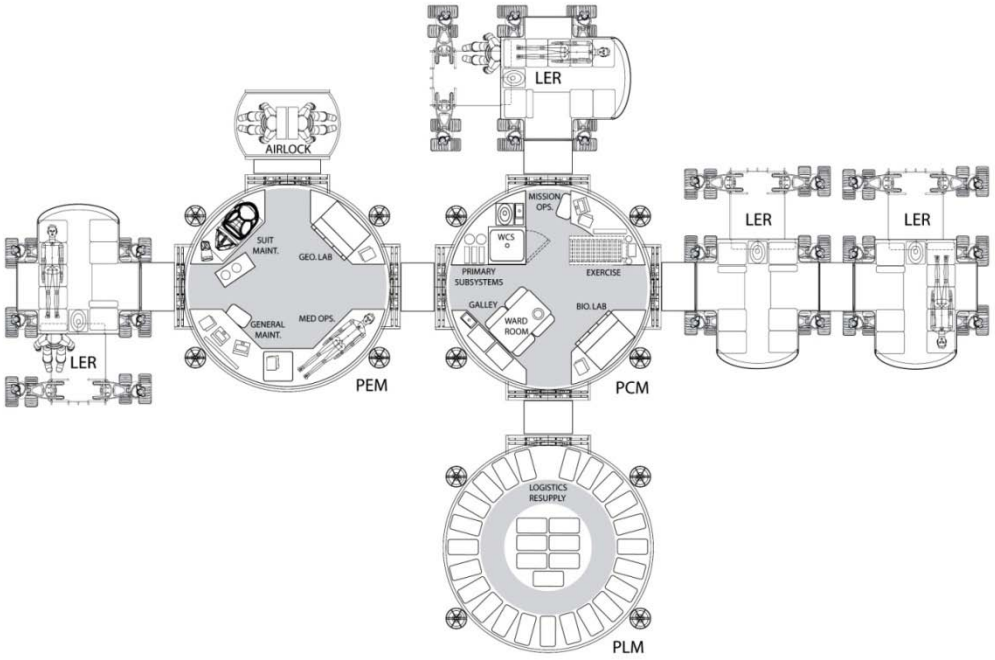
UTAF Support for Space Exploration Vehicle (SEV)

- **HF plays a major role in designing the vehicle's nose, window placement, and interior functionality**
- **HF engineers participated in two DRATS habitability studies (3 and 14 days) examining areas like driving, displays & controls, visibility, EVA, daily operations, sleep, and exercise, etc.**
- **Using lessons learned from the two field tests, some redesign of visibility, software, cabin, storage, and suit ports has been implement to improve the crew's efficiency**
- **A GEN 2 SEV is in the design phase today**

UTAF Support for the Habitat Demonstration Unit (HDU)

- **NASA's Lunar Surface Systems team is constructing the Habitat Demonstration Unit (HDU) to test crew habitability, subsystems, and procedures for lunar missions**
- **UTAF will support displays and controls development for the HDU as well as testing the NHV**





Commercial Orbital Transportation Services (COTS)

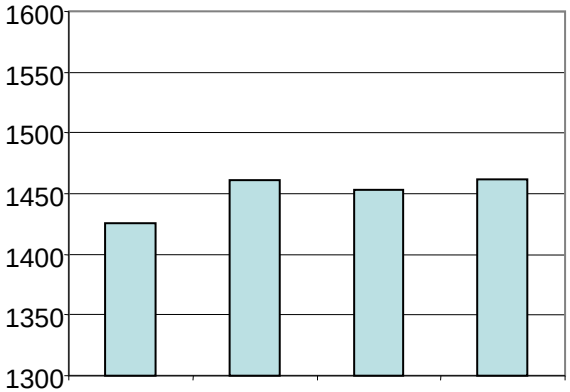
Orbital

SPACEX

Commercial Human Systems Integration Requirements Development

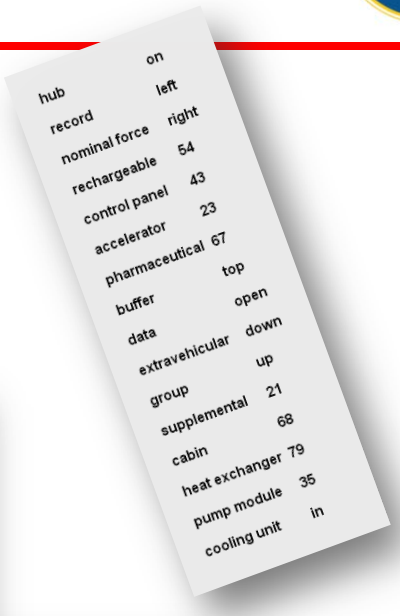
- **Development of the Commercial Human Systems Integration Requirements (CHSIR) for the COTS program**
  - **Leveraging CxP experience**
  - **Offering Subject Matter Experts (SMEs) in a number of Human Factors areas**
    - **Crew hardware and software interface design**
    - **Displays and controls**
    - **Electronic procedures**
    - **Net habitable volume**
    - **Usability and workload**

Human Research Program – Space Human Factors Engineering

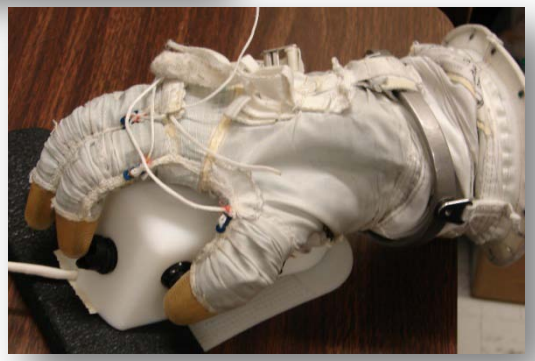


Information Presentation Research

- **Displays**
  - Label alignment
  - Alarms
  - Multi-monitor interaction
  - Color Coding
  - Head Mounted Displays
- **Controls**
  - Cursor control device design
  - Cursor movement
  - Dual-task performance
  - Pressurized gloved operations
- **Vibration**
  - Readability under vibration
  - Use of cursor control devices under vibration



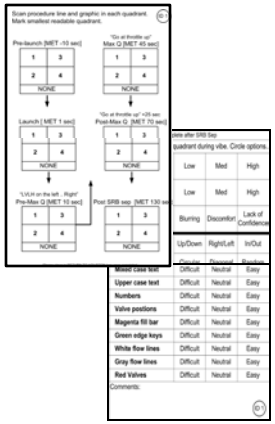
Cursor Control Device Studies



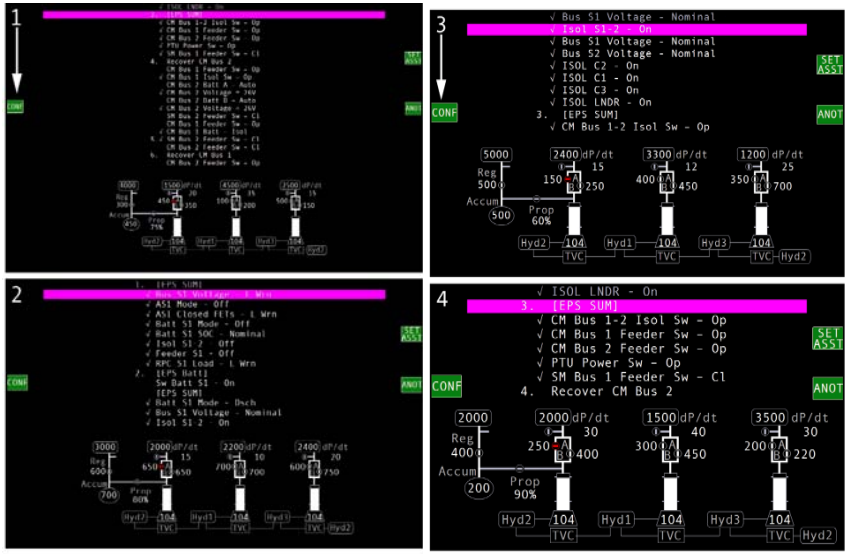
Short Duration Bioastronautics Investigation (SDBI-1904)

Visual Performance Under Shuttle Launch Vibration

- **Objectives**
  - **Provide operational data to supplement ground-based studies aimed at understanding human performance limits under vibration**
  - **Provide crew readability data to be used in conjunction with DTO 695, which measures Shuttle seat vibration**
  - **Assess readability of different font sizes under vibration, using Orion-like display formats**
- **Task**
  - **During each ascent phase, scan the placards and determine the smallest readable display**



Mid-deck placards and response card



Placard showing 4 displays/font sizes

Training Research

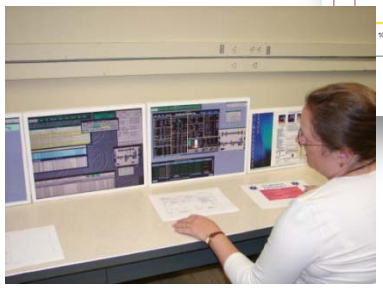
Research focuses on space medical operations training for both crewmembers and ground support

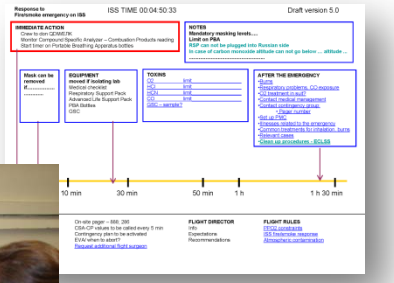
Feasibility of Crew Medical Officer (CMO) just-in-time (JIT) training & procedures tools evaluations

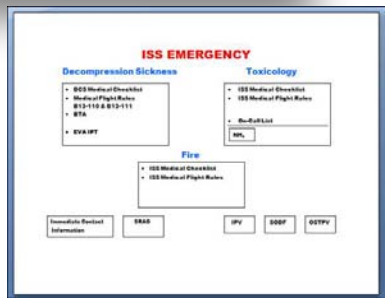
- **Head mounted display**
- **Wrist mounted displays**
- **Combined auditory instructions with graphics displays**

Conceptual development of flight surgeon performance support tool for responses to vehicle emergencies (Fire, Decompression, and Toxic Exposure)

- **Flight surgeon formative evaluation**
- **Paper prototype development**
- **Electronic prototype development**







Usability Research

- **Areas of Focus**
  - **Usability factors: efficiency, effectiveness, and satisfaction**
  - **Errors: metrics, methods, and requirements**
  - **Consistency scale development and testing**
  - **Legibility methods and requirements**
  - **Maneuverability Assessment Scale development and testing**